Macroeconomic Aggregates, Pricing Kernels and Expected Default-Free and Defaultable Bond Returns

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Why do defaultable (corporate) bond returns change over time?

- Expected cash-flows change (e.g. expected default loss)

- Time-discounting and risk attitudes, and demanded risk compensation change

Main Question

How are these changes related to business cycles and macroeconomic conditions?

Outline

- Introduction, Motivation and Literature
- Modeling and Estimation Framework
- Data
- Results
- Some future work

Expected Default Loss

- Default rates are counter-cyclical and recovery rates are pro-cyclical

- Blume and Keim (91), Fons and Kimball (91), Jonsson and Fridson (96), Duffie and Singleton (03), Gupton and Stein (02)

Risk Premia

- Fama and French (89) (stocks and corporate bonds), Ludvigson and Ng (06) (Treasury bonds): investors are more risk-averse and demand higher expected returns in recessions

- Forecasting regressions of excess returns on lagged macroeconomic aggregates

Macro-economic Variables and Term Structure of Credit Spreads

- Hackbarth, Miao and Morellec (06): a structural model where macroeconomic variables influence firms' cash flows

- Wu and Zhang (07): macro variables in a (reduced-form) affine no-arbitrage term-structure model

Our approach in relation to literature

- Our work: in between forecasting regressions and reduced-form term-structure models
- Why? - to focus on expected returns under no-arbitrage-type multivariate restrictions

This work - Objectives

- Link multiple returns of Treasury and defaultable bonds with lagged forward rates and macroeconomic variables within unified no-arbitrage-type framework

- No assumptions on underlying dynamics; potentially flexible functional forms; return data determines importance of each of multiple forecasting variables

Preliminary Concepts

Asset pricing (Euler) equation:

$$p_t = E[m_{t+k} y_{t+k} | \mathcal{F}_t] \Rightarrow$$
$$1 = E[m_{t+k} R_{t+k} | \mathcal{F}_t]$$

where m_{t+k} is the pricing kernel;

y_{t+k} is payoff at time $t+k$; $R_{t+k} = \frac{y_{t+k}}{p_t}$

This work - Methodology Overview

- Jointly utilize two sets of Euler-equation-type moment conditions: for Treasury and defaultable returns

- Defaultable return differs from Treasury return by *credit return premium*

Credit Return Premium

From credit spread to credit return premium:

$$y_t^c = y_t^g + s_t \quad \Rightarrow R_t^c = R_t^g f_t$$

where y_t - log-yield; R_t - simple total return

This work: Methodology Overview, Contd.

- Pricing kernel and credit return premia are functions of forecasting variables

- Pricing kernel enters the moment conditions for both Treasury and defaultable returns, whereas *credit return premia* only enter defaultable return conditions

Euler-equation-implied Moment Conditions

$$E[(m_{t+k}\mathbf{R}^{g}_{t+k} - 1) \otimes \mathbf{Z}_t] = 0$$
$$E[(m_{t+k}\mathbf{c}_{t+k}\mathbf{R}^{c}_{t+k} - 1) \otimes \mathbf{Z}_t] = 0$$

where $\mathbf{c}_{t+k} = \mathbf{f}^{-1}_{t+k}$, $\mathbf{Z}_t$ is a vector of instruments.

Modeling - Indexes

$$\begin{aligned} m_{t+k}(\mathbf{X_t}) &= m_{t+k}(I_{1t}, I_{2t}) \\ \mathbf{c}_{t+k}(\mathbf{Y_t}) &= c_{t+k}(I_{3t}, I_{4t}) \end{aligned}$$

To reduce dimensionality, we group the forecasting variables $\mathbf{X}$ and $\mathbf{Y}$ into two categories and form an index within each group

Modeling - Indexes, Contd.

- I_{1t} and I_{3t} are indexes of forward rates (shown to be good predictors of Treasury returns by Cochrane and Piazzesi (05))

- I_{2t} and I_{4t} are indexes of macro variables

- index = linear combination

Data

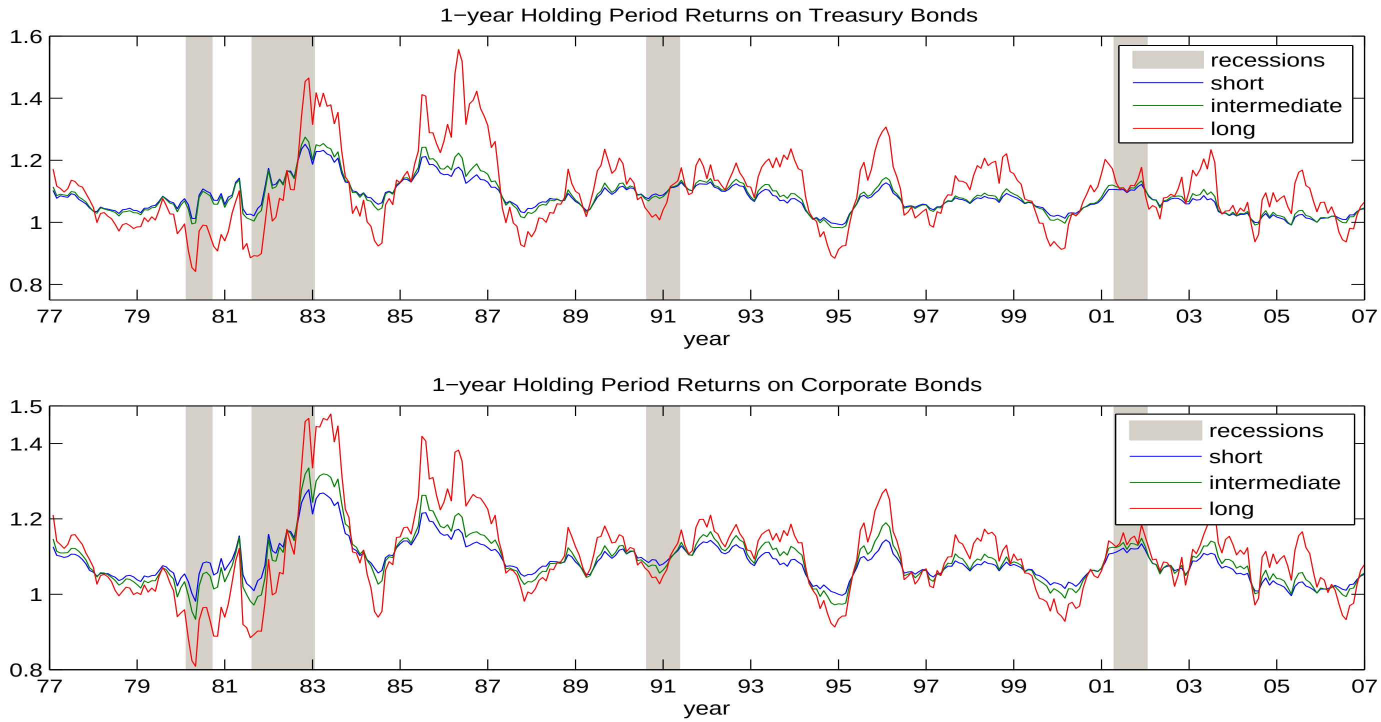
- Monthly one-year holding period returns on US Aggregate Treasury and Credit Indices from Lehman Brothers Global Family of Indices of short (1-3 years), intermediate (3-5 years), and long (more than 20 years) maturities

Data - Contd.

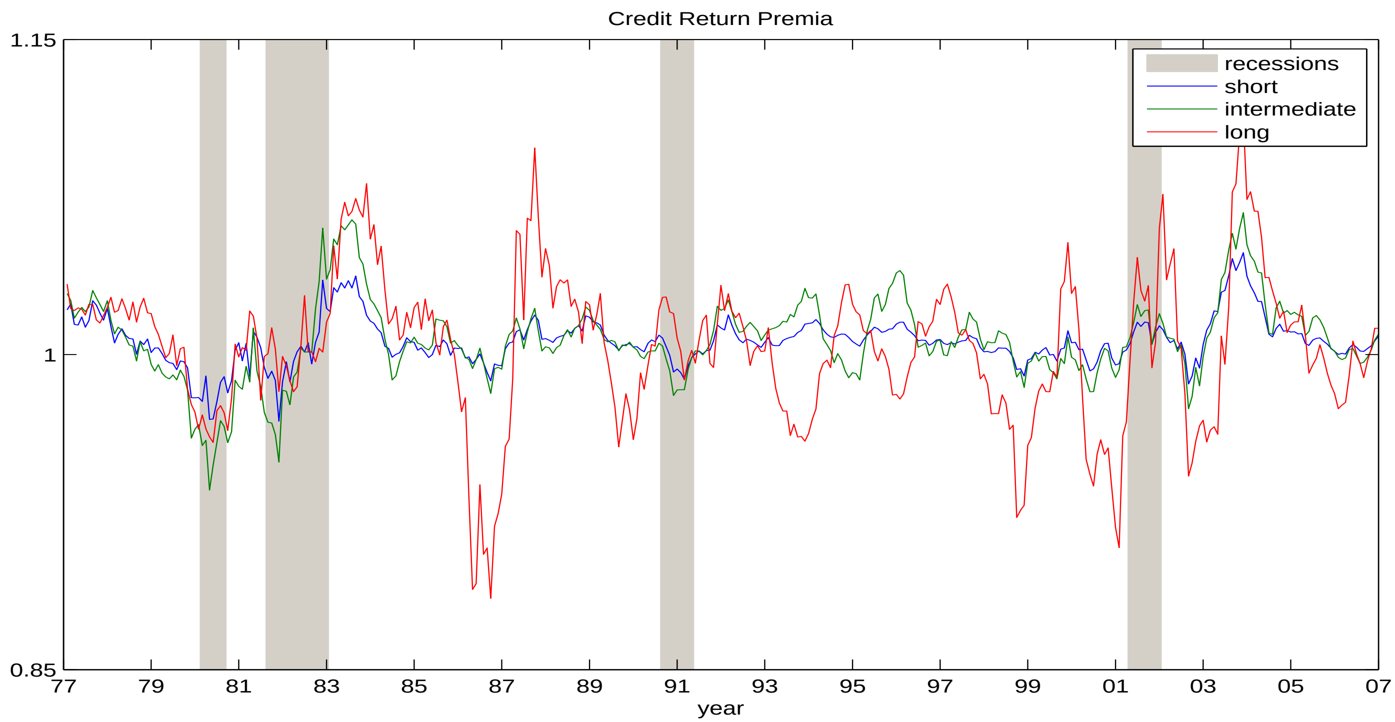
- Sample period range is from December 1976 through December 2006

- Unsmoothed Fama-Bliss forward rates

- Monthly data from the FRED on
  Nominal macro variables: CPI, PPI, M2
  Real macro variables: IP, EMPLOY, PCS, HS.



Time Series of Treasury and Credit Index One-Year Holding Period Returns



Time Series of Sample Credit Return Premia

Initial Analysis (Forecasting Regressions)

$$
\begin{aligned}
R_{t+12} &= \mathbf{F}_t\alpha + \epsilon_{t+12} \\
\frac{R^c_{t+12}}{R^T_{t+12}} &= \mathbf{F}_t\beta + \eta_{t+12}
\end{aligned}
$$

- Forward rates have higher forecasting power for gross returns than macroeconomic variables

- Macroeconomic variables are better in forecasting the excess credit returns: adj-$R^2 =$ .36(.12) with only macro variables, adj-$R^2 =$ .1(.03) with only forward rates

GMM estimation

- Euler-equation-generated moment conditions for six returns: Treasury and credit of three maturities

- Instruments: all lagged forecasting variables and a const

- Estimated: parameters in the pricing kernel and credit return functions and weights of forecasting variables within each index:

$$
\begin{aligned}
m(.) &= \theta_0 + \theta_{0,1} i_{1,t} + \theta_{0,2} i_{2,t} \\
i_{1,t} &= \sum_{j=1}^{5} \theta_{1,j} f_t^{(j)} \\
i_{2,t} &= \theta_{2,1} CPI_t + \theta_{2,2} PPI_t + \theta_{2,3} M2_t + \\
& \quad \theta_{2,4} IP_t + \theta_{2,5} EMPLOY_t + \theta_{2,6} PCE_t \\
& \quad s.t. \quad \|\theta_1\| = \|\theta_2\| = 1.
\end{aligned}
$$

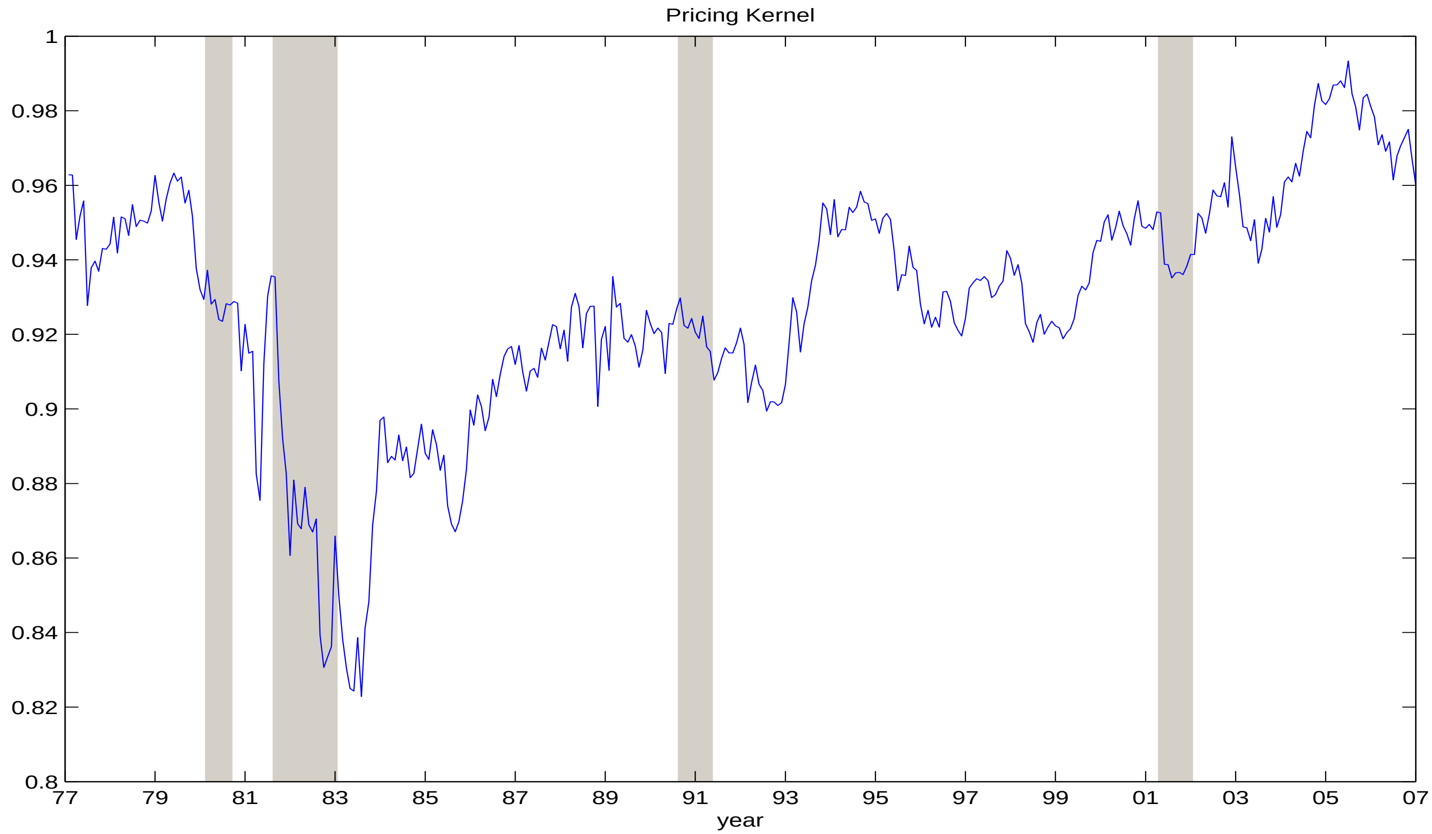
$$
\begin{aligned}
\mathbf{c}_t(\Gamma) &= \left[c_t^{(i)}(.), \quad i = Short, Interm, Long\right] \\
c_t^{(i)}(.) &= \gamma_0^{(i)} + \gamma_{0,1}^{(i)} i_{3,t} + \gamma_{0,2}^{(i)} i_{4,t} \\
i_{3,t} &= \sum_{j=1}^{5} \gamma_{1,j} f_t^{(j)} \\
i_{4,t} &= \gamma_{2,1} CPI_t + \gamma_{2,2} PPI_t + \gamma_{2,3} M2_t + \\
&\quad \gamma_{2,4} IP_t + \gamma_{2,5} EMPLOY_t + \gamma_{2,6} PCE_t \\
&\quad s.t. \quad \|\gamma_1\| = \|\gamma_2\| = 1.
\end{aligned}
$$

Empirical results-GMM estimation

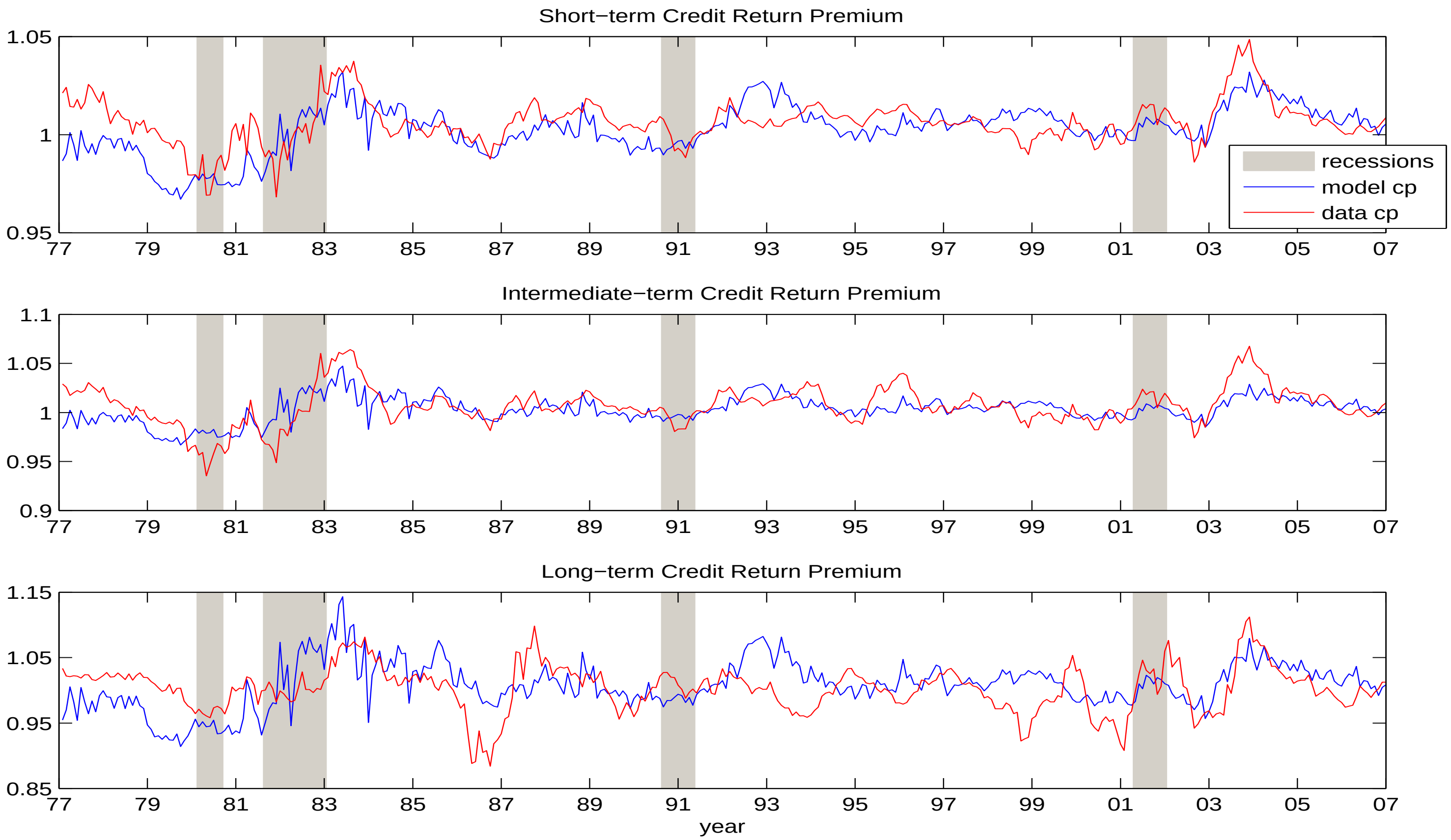
- χ^2: Unrestricted model significantly outperforms the restricted ones
  $\Rightarrow$ both forward rates and macro variables are important in forecasting credit return premia

- Pricing kernel tends to increase before or at the very beginning of recessions.

- Credit return premia tend to increase during recessions; countercyclical



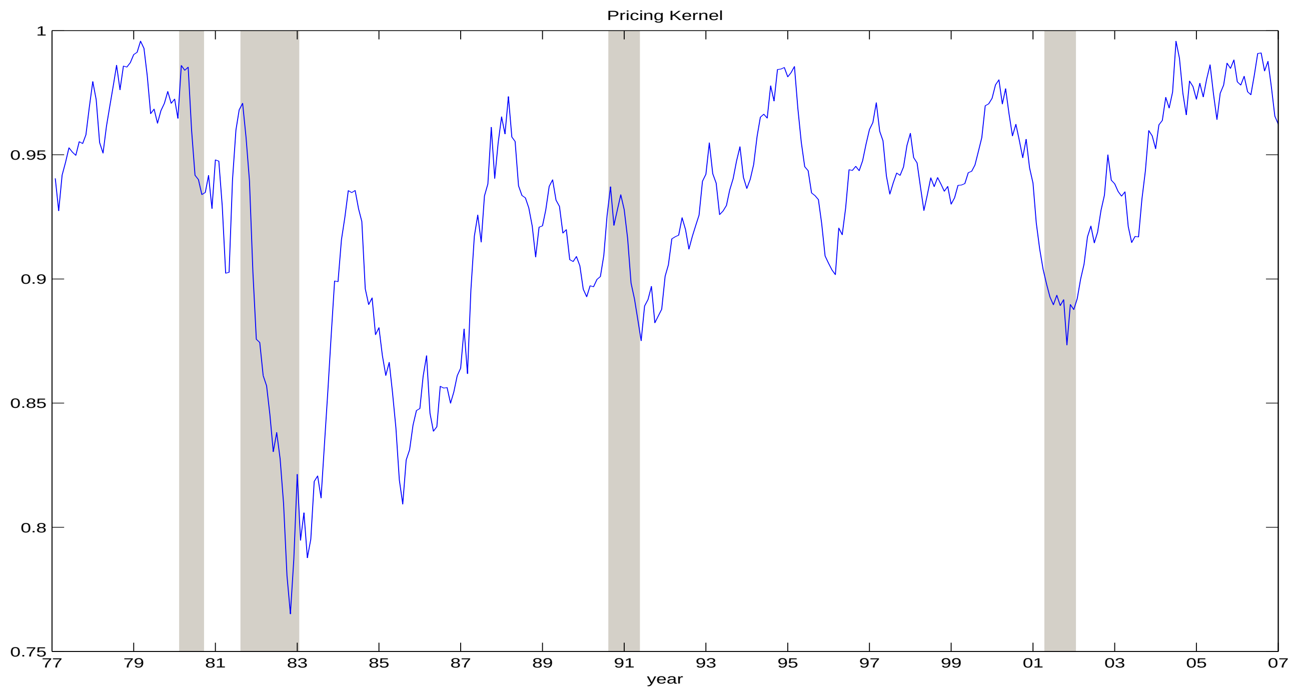
Time Series Model-implied (Linear) Pricing Kernel (Model with Linear Credit Premia)


Short−term Credit Return Premium
1.05
1
0.95
77
79
81
83
85
87
89
91
93
95
97
99
01
03
05
07
recessions
model cp
data cp
Intermediate−term Credit Return Premium
1.1
1.05
1
0.95
0.9
Long−term Credit Return Premium
1.15
1.05
0.95
0.85
year

Changing Timing

- m_{t+k} and $\mathbf{c}_{t+k}$ are functions of variables at time $t + k$ rather than t

- patterns of pricing kernel and credit return premia remain more or less stable



Time Series of Pricing Kernel Implied by the Model in which the Pricing Kernel and the Credit Return Premia are Linear Functions of State Variables at time $t + 12$

Time Series of Credit Return Premia Implied by the Model in which the Pricing Kernel and the Credit Return Premia are Linear Functions of State Variables at time $t + 12$

Conclusions

- We try to understand the sources of variation in excess returns on defaultable bonds

- Macroeconomic variables help in predicting future bond returns under no-arbitrage after controlling for the term-structure factors

Conclusions - Cond.

- Time series of estimated pricing kernel and credit return premia demonstrate patterns consistent with the previous findings on counter-cyclical behavior of risk aversion and default rates and pro-cyclical behavior of recovery rates

Future Work

- Non-linearities in pricing kernel and credit return premia $\Rightarrow$ potentially greater flexibility to fit returns of longer maturities

- Alternative forecasting variables. E.g.: stock market volatility, investor sentiment?

- Effects of credit market events